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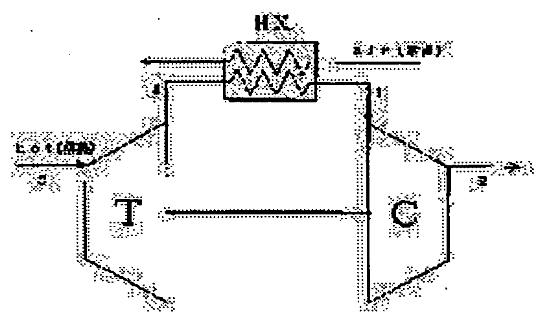
(54) THERMAL ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the energy efficiency by flowing the hot gas of the normal pressure or the pressure close thereto into a turbine to achieve the work, exchanging the heat of the hot gas leaving the turbine with cooling air to drop the temperature of the gas, and flowing the gas into a compressor to generate the output.
SOLUTION: The gas 3 of high temperature and normal pressure is introduced in a turbine T to achieve the work, and the gas 4 which completes the work and is discharged flows into a heat exchanger HX, and the temperature is dropped to the normal temperature or the temperature close thereto through the heat exchange with the cooling air. After the gas 1 whose temperature is dropped is fed to a compressor C to rotate it, the gas is discharged outside. The turbine T can be driven with the gas of normal pressure by arranging the compressor C on the downstream side of the turbine T, and the difference between the output of the turbine T and the input required by the compressor C is taken out as the engine output. The gas to be used includes the exhaust gas from the engine and the hot gas generated in treatment of the refuse.



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審査請求　未請求　請求項の数３　書面　（全 ９ 頁）

(21)出願番号　特願平9－103804

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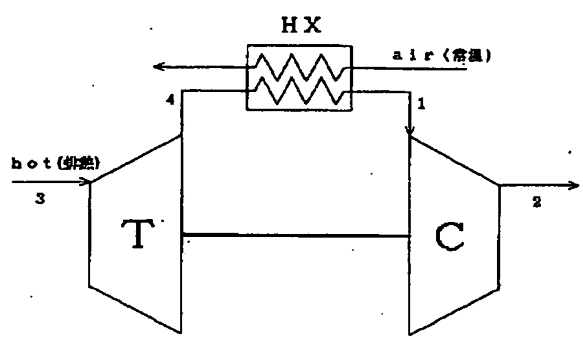
(54)【発明の名称】　サーマルエンジン

(57)【要約】　（修正有）

【課題】常圧かそれに近い圧のガスを利用してガスの持つ熱エネルギーを動力に変換したり冷凍に利用する装置に関するものである。

【解決手段】ガスが高温の時はタービンＴから流入させ熱交換器ＨＸで温度を下げて圧縮機Ｃから排出し軸出力を得る。ガスが常温に近いときは熱交換器ＨＸで温度を上げれば冷凍機として作動できる。あるいは高温の圧力の高くない排ガスを熱交換器ＨＸで熱交換して出力を得る。



【特許請求の範囲】

【請求項１】　常圧またはそれに近い圧力の高温ガスをタービンに流入させタービン出口後に熱交換してガスの温度を下げ圧縮機に流入させて出力を得ることを特徴とする装置。

【請求項２】　常温またはそれに近い温度のガスをタービンに流入させタービン出口後に熱交換してガスの温度を上げ圧縮機に流入させて請求項１の装置の出力または他の一般的な動力を利用して冷凍機として作動させることを特徴とする装置。

【請求項３】常温またはそれに近い温度のガスを圧縮機から吸入し車のエンジンの排熱のように圧力の高くない低密度の外部の高温ガスと熱交換して内部のガスの温度を上げタービンに入れて軸動力を得ることを特徴とする装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】ガスタービンや車両エンジンまたは産業用レシプロエンジンあるいはゴミ焼却など排熱が利用できるときこの発明を用いることによりエネルギー利用効率を向上させることができる。また本発明を空気を利用した冷凍機すなわちエアサイクルとして用いることができる。

【０００２】

【従来の技術】圧力の高くないガスの排熱を利用して動力を得るには通常は蒸気タービンまたは温水器を通して行われており、また冷凍機として作動させるときは圧縮機から流入させ熱交換して温度を下げてタービンに流入させているがタービン入口で常温まで温度を下げることが困難なことと相まって成績係数が低い。

【０００３】

【発明が解決しようとする課題】圧力の高くないほぼ常圧の高温ガスの熱源を利用するにさいし、液体を用いて蒸気または温水に変換する従来技術は復水器を必要とし複雑なシステムになる。あるいは液体を用いずタービンで排熱回収できるが、例えば車両用エンジンの排気口に直接タービンを置くと比較的大きな背圧がかかり元のエンジンの性能を害する。本発明はこれらの欠点を克服し簡単なシステムで効率の良い排熱利用を行うものである。一方本発明において排熱でなく常温のガスに用いて冷凍サイクルの成績係数を向上させようというものである。

【０００４】

【課題を解決するための手段】本発明の請求項１に相当する概念図を図１に、ガスの作動状態を示す温度Ｔ・エントロピーＳ線図を図２に示す。高温・常圧のガスがタービンＴに流入し熱交換器ＨＸで温度を常温またはそれに近い温度まで下げて圧縮機Ｃへ流れ外界に排出される。常圧のガスでタービンが作動できるのは圧縮機が後方にあるためでタービンの出力と圧縮機の必要とする入力の差がエンジン出力として取り出される。タービンへのガスとしてはいろいろな形態のエンジンやガスタービンの排ガスを利用すれば良い。あるいはゴミ処理で生じた高温ではあるが圧力の高くないガスも利用できる。このことを図２で説明すると３の状態にある温度Ｔ・エントロピーＳを有するガスがタービンを通過すると４の状態になる。熱交換器で熱を奪うと４から１の状態に移り圧縮機で加圧ならびに加熱して２の状態になり外界に排出される。請求項２に述べたように高温ガスの代わりに常温ガスがタービンに流入すると冷凍機として作動できる。この場合は外部から不足する分だけ入力を別の機関で加える必要がある。

【０００５】車のエンジンからの排熱のように通常の方式ではもはやエネルギー回収し軸動力にすることが困難なときその排ガスを用いて、図３に示したように、熱交換器ＨＸで圧縮機Ｃを通ったガスの温度を上げてタービンＴに流入させ圧縮機の入力とタービンの出力の差を利用して軸出力を得る。この装置ＰＡＳは請求項３に相当するものである。請求項１および３の装置はいずれもタービンと圧縮機の出力、入力がバランスするすなわちアイドリングになるまで外部から始動入力を投入する必要があり、一般のガスタービンの運転手順と同じである。

【０００６】

【作用】常圧の高温ガスは従来蒸気あるいは温水に変換しなければ利用できなかったが本発明では蒸気などに変換することなく熱交換だけで動力として直接利用できる。冷凍機として作動させるときはタービン入口が必ず常温またはそれに近い温度すなわち外気温度であり、流入のとき熱交換器の性能に左右されない。

【０００７】

【実施例】本発明による請求項１の装置ＴＧをガスタービンと組み合わせて利用する場合を図４に示す。この図においてＢは燃焼器、ＨＸは熱交換器、Ｃは圧縮機、Ｔはタービンとする。ガスの作動状態を図５に示す。Ｇ１の状態にある空気を吸ってＧ２に圧縮されＧ２からＧ５’までは排ガスの熱を利用する再生によって温度が高められＧ５’からＧ３までが燃焼によってさらに高温になる。このガスがタービンを通過することによって常圧高温の空気Ｇ４になる。これを改めてＴ３の状態と名付ける。本発明の請求項１の装置ＴＧに付いているタービンによってＴ４の状態に温度が下がる。この高温ガスがさらに熱交換によってＧ６’さらにＴ１に下げられる。Ｔ４からＴ６’にいく過程で生じる熱はガスタービン内のガスをＧ２からＧ５’に上げるのに使われる。Ｇ６’からＴ１へは外部から強制的に冷却する。Ｔ１からＴ２には圧縮機によって加圧され外界に放出される。このサイクル線図は図５でみるように常温にちかい部分があたかもガスタービン単体で圧縮機の中間冷却を行った場合になっている。このような形態を熱力学的に計算し結果を図６に示す。この図で縦軸が本発明の装置ＴＧによる

出力ΔT_{WTG}を温度の単位で表し横軸がＴＧのタービン通過に伴う膨張比π_tを示す。ＴＧの熱交換の効率を１．０としガスタービンへの再生の際の熱交換の効率を０．８，０．４，０の３種類変化させ、かつＴＧの圧縮機に中間冷却をした場合としない場合に分けて計算した。ここで熱交換の効率は一般に知られているように実際の伝熱量と最大可能な伝熱量の比とした。図中η_eはガスタービンおよびＴＧの要素の断熱効率であり０．７０とあるのはガスタービンおよびＴＧの圧縮機とタービンがすべて７０％の断熱効率で作動していることを示している。ここでは要素の断熱効率を２種類変えて０．７０，０．７５を計算した。いずれの場合も本発明の装置ＴＧから出力が得られることが判明した。

【０００８】図７に請求項１に述べた本発明の装置ＴＧの出力を利用するために通常のエアサイクル冷凍機を直結した場合を示す。これに対応する温度Ｔ・エントロピーＳ線図を図８に示す。冷凍機では冷凍能力に対する必要入力の比すなわち成績係数ＣＯＰが重要である。要素の断熱効率η_eを２種類（０．７０、０．７５）変えさらにガスタービンへの再生のための熱交換器効率ε_{GR}を３種類（０．８，０．４，再生なし）変えてＣＯＰとエアサイクル入口と出口の温度差ΔT_cの関係を熱力学の方程式に基づいて計算したのが図９である。一点鎖線がエアサイクルのみであるのに対していずれの条件下においても飛躍的に成績係数ＣＯＰが改善されている。

【０００９】請求項２に述べた本発明の装置ＧＴを冷凍機として用いたときの概念図を図１０に、相当する温度Ｔ・エントロピーＳ線図を図１１に示す。３の状態の空気をタービンにより膨張させ温度を下げ外部と熱交換し４から１の状態に再び温度を上げる。熱交換により得られた冷たい外部空気は冷房または冷凍に使える。熱力学計算を行い成績係数ＣＯＰに関して通常のエアサイクル（ＡＩＲＣＹＣＬＥ）とＴＧを比べたのが図１２、１３である。図１２は圧縮機とタービンのそれぞれの断熱効率ηc、ηt（$\eta c=\eta t$とする）の変化に対する成績係数ＣＯＰを比べている。熱交換の温度効率は$\eta r=0.7$にしてある。要素の断熱効率が悪くても本発明によるＴＧは従来のエアサイクルよりＣＯＰが大きい。現在の空気力学的設計技術からは小型圧縮機やタービンでは要素の断熱効率０．８以上は望めそうもないことからみるとＴＧはエアサイクルに比べて有利である。図１３は熱交換器の温度効率ηrに対するＴＧの優位性を示したものである。計算では$\eta c=\eta t=0.75$、圧力比$\pi=2.0$とした。現実的には温度効率０．８以上は考えにくいことを考慮すると温度効率が悪いときでもＴＧの優位性は変わらない。

【００１０】請求項３に述べた本発明による装置ＰＡＳを車のエンジンに応用して排熱を利用する補助動力として作動させ車両クーラーの経済性を高めた場合の概念図を図１４に示す。前述のＴＧを冷凍機として用いても良いがここでは説明を簡潔にするために通常のエアサイクルを連結した場合を述べる。図１５は対応する温度Ｔ・エントロピーＳ線図であるが高温の排ガスと熱交換してＰ２からＰ３にＰＡＳ内のガスの温度を上げタービン通過後Ｐ４になり排出される。これにより得られる出力とエンジンの出力を加えてエアサイクルを作動させる。このようなシステムに対して熱力学計算を行い表示したのが図１６である。この図においてＥＣＯＰは新たに定義する経済的成績係数である。一般に冷凍能力とそれに必要な入力の比で成績係数ＣＯＰが定義されているが、今の場合排ガスというそのままでは無駄になってしまうエネルギーを使っているのでＰＡＳによって生じる出力を冷凍に必要な入力から差し引いて成績係数を求めたものを経済的成績係数ＥＣＯＰとする。すなわち物理的に厳密なＣＯＰとは異なり経済的見地から成績係数を調べたことになる。図ではη_{Pc}，η_{Tc}はＰＡＳの圧縮機とタービンの断熱効率である。同様にη_{Cc}，η_{Ct}はエアサイクルの圧縮機とタービンの断熱効率とする。ΔT_cはエアサイクルによる温度降下とする。この図からみてＰＡＳを用いるとエアサイクルの経済的成績係数を向上させられることがわかる。

【００１１】本発明の装置ＴＧをゴミ処理施設に応用した例を図１７に示す。この場合にはガスタービンやエンジンの代わりに補助動力Ｍｏｔｏｒを必要とする。

【００１２】本発明の装置ＴＧをゴミ焼却炉に応用しかつ蒸気タービンに連動させた例を図１８に示す。この図でＰｕｍｐはポンプ、Ｃｏｎは復水器を示す。排熱利用を従来の２段階から３段階にしてシステムの最高温度の部分をまず本発明の装置ＴＧで利用してある程度温度が下がつた状態でボイラにいれる。従来、ボイラに高温でいれると材料の関係で腐食が起こるので水などで冷却しわざわざ温度をさげていた。

【００１３】請求項１の本発明の装置ＴＧの代わりに請求項３の装置ＰＡＳをゴミ焼却炉に用いた場合をを図１９に示す。

【００１４】

【発明の効果】本発明の請求項２の装置ＴＧではタービンに先にガスを流入させているので一般に実現の困難な熱交換の効率１００％が流入時において常に保証されている。また高温ガスのときタービンで１００から１５０度程度の温度降下があるのでその後に続く熱交換器の材質選定が有利になる。熱力学の方程式では圧力比の形で計算されるので比が同じのとき負圧力の方が圧力差の絶対値が少ないので構造的に有利になる。

【００１５】図７，８，９でエアサイクルの成績係数ＣＯＰが本発明の装置ＴＧにより増加した効果を次に述べる。Ｑの冷凍能力を得るにはＷの仕事が必要であるときＣＯＰ＝Ｑ／Ｗが一般に定義されている。本発明の装置をつけると図８に示したようにサイクル線図ではあたかも中間冷却を行ったようになりガスタービン単体の効率

EがE_tに上昇する。そのために

$COP=Q/(W-G(E_t-E))$

の関係からＣＯＰが向上する。上の式でＧは入力ガスのもつ熱量とする。もしガスタービンが発電をしないで冷凍機だけを駆動するのに使用したとすれば冷凍能力と入力の比QE/WがQE_t/Wに改善され$G(E_t-E)$だけガスの熱量が節約できる。

【図面の簡単な説明】

【図１】請求項１の概念図

【図２】温度Ｔ・エントロピーＳ線図

【図３】請求項２の概念図

【図４】ガスタービンと組み合わせて請求項１の装置ＴＧを利用する場合の概念図

【図５】温度Ｔ・エントロピーＳ線図

【図６】出力と膨張比の関係図

【図７】ガスタービンに本発明の装置ＴＧを組み込んだ概念図

【図８】温度ＴとエントロピーＳ線図

【図９】冷凍機による温度降下と成績係数の関係図

【図１０】請求項２による装置の概念図

【図１１】温度Ｔ・エントロピーＳ線図

【図１２】成績係数と要素効率の関係

【図１３】圧縮比と要素効率を固定した場合の温度効率と成績係数の関係

【図１４】請求項３の装置ＰＡＳを車の補助動力として用いた場合の概念図　＊

＊【図１５】温度Ｔ・エントロピーＳ線図

【図１６】温度降下と経済的成績係数の関係

【図１７】請求項１の装置ＴＧを焼却炉に用いたときの概念図

【図１８】請求項１の装置ＴＧを蒸気機関の前方に用いたときの概念図

【図１９】請求項３の装置ＰＡＳを焼却炉に用いたときの概念図

【符号の説明】

Ｔはタービンまたは温度

ＨＸは熱交換器

Ｃは圧縮機

Ｓはエントロピー

ＴＧは本発明による請求項１および２の装置

ＰＡＳは本発明による請求項３の装置

η_eはタービンと圧縮機の要素効率

ΔT_cは温度降下量

Ｐｏｍはポンプ

Ｃｏｎは復水器

Ｂは燃焼器

ＣＯＰは成績係数

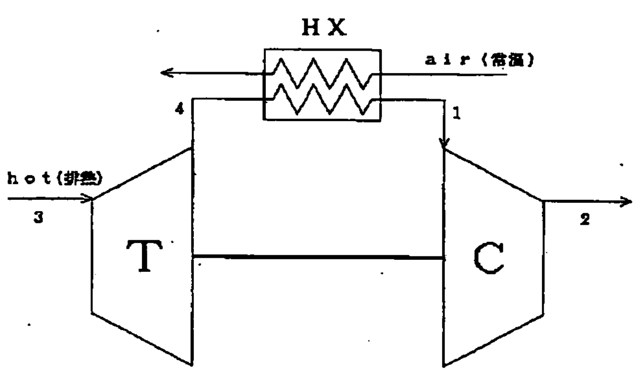
ＥＣＯＰは経済的成績係数

ηc、ηtはそれぞれ圧縮機、タービンの断熱効率

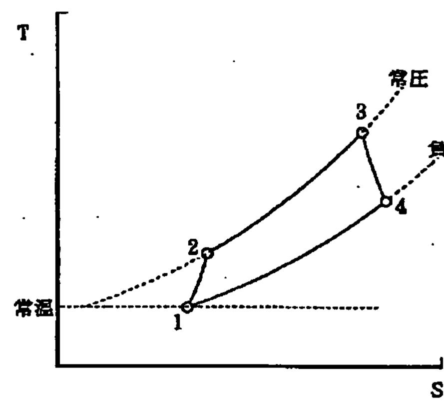
ε_{GR}は熱交換効率

πは圧力比または膨張比

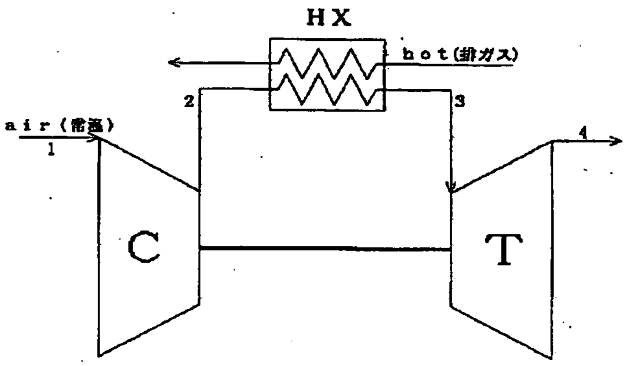
【図１】



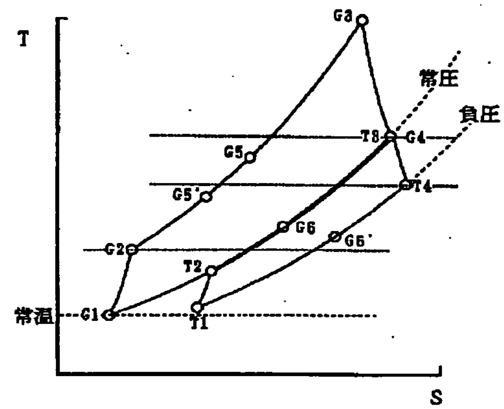
【図２】



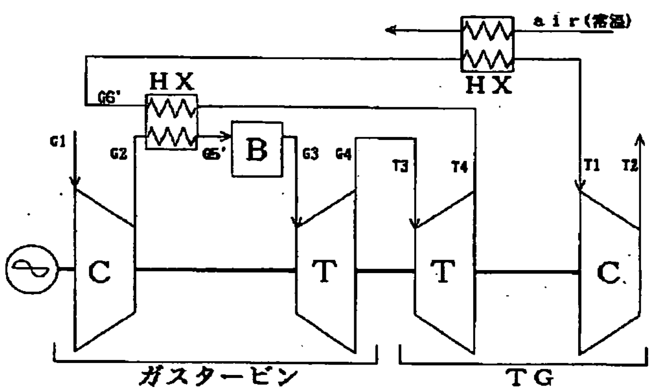
【図３】


ＨＸ
hot(排ガス)
air(常温)
1
2
3
4
C
T

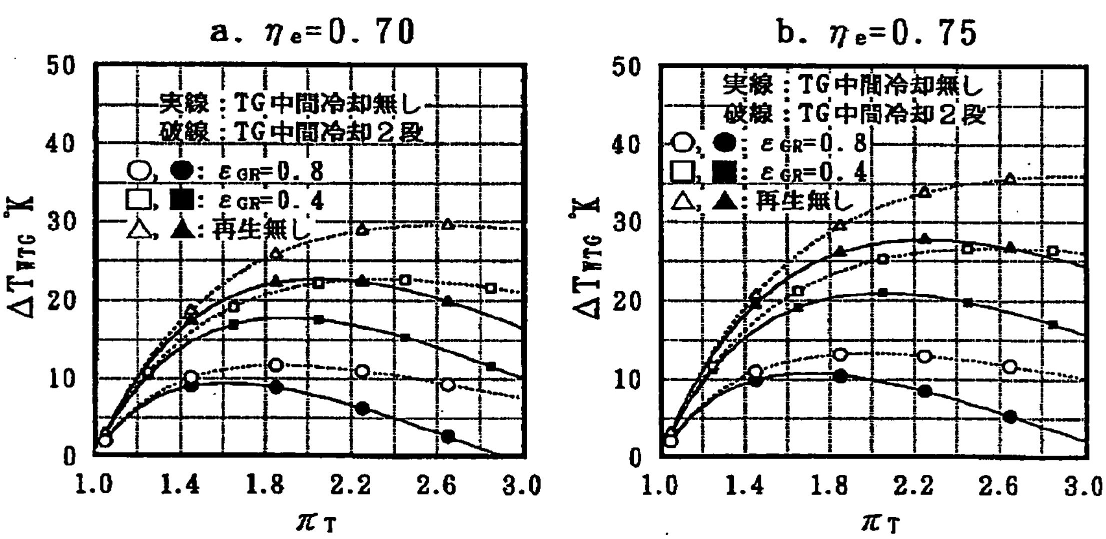
【図５】


T
S
常圧
負圧
常温
G1
G2
G3
G4
G5
G5'
G6
G6'
T1
T2
T3
T4

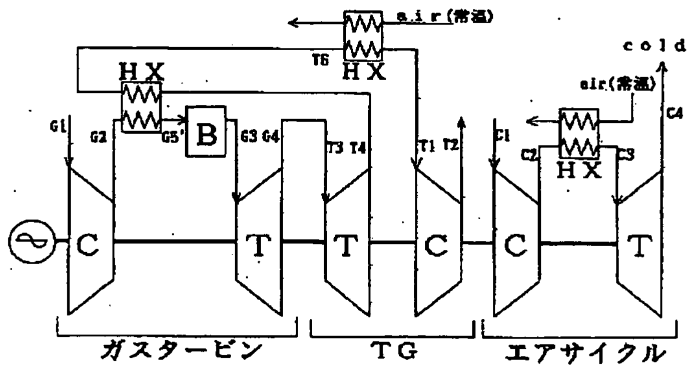
【図４】


air(常温)
ＨＸ
ＨＸ
G6'
G1
G2
G5'
B
G3
G4
T3
T4
T1
T2
C
T
T
C
ガスタービン
ＴＧ

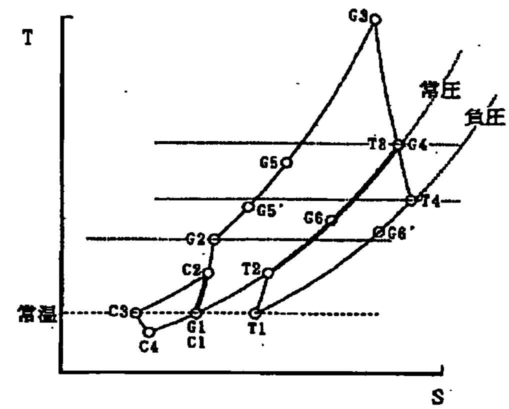
【図６】


a. η_e=0.70
b. η_e=0.75
実線：TG中間冷却無し
破線：TG中間冷却２段
○,●：ε_{GR}=0.8
□,■：ε_{GR}=0.4
△,▲：再生無し
ΔT_{WTG} K
π_T
0
10
20
30
40
50
1.0
1.4
1.8
2.2
2.6
3.0

【図7】

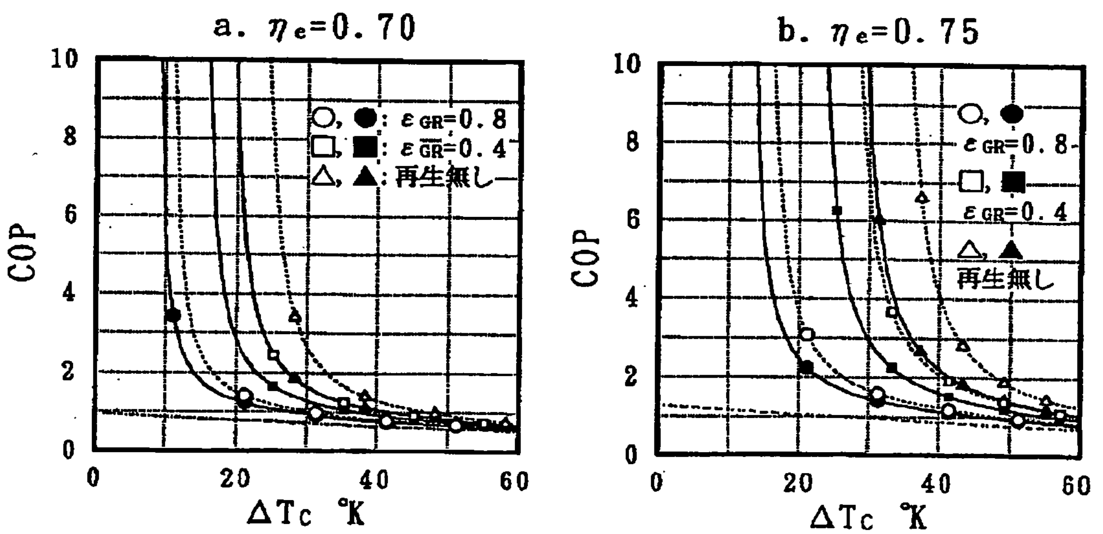


【図8】



【図9】

実線：TG中間冷却無し
破線：TG中間冷却2段
一点鎖線：エアサイクルのみ



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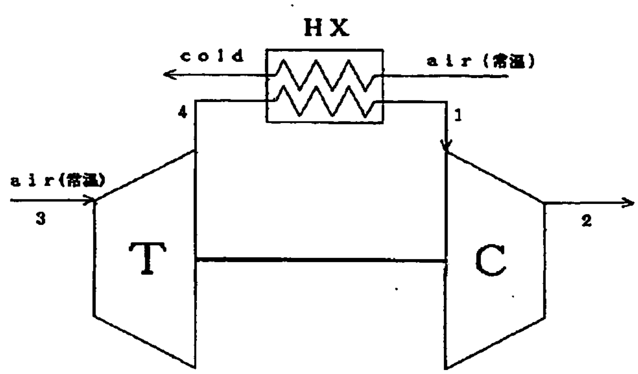
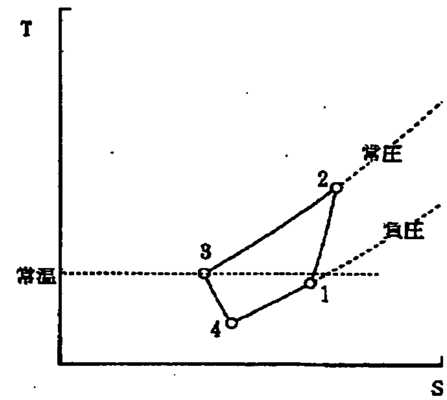
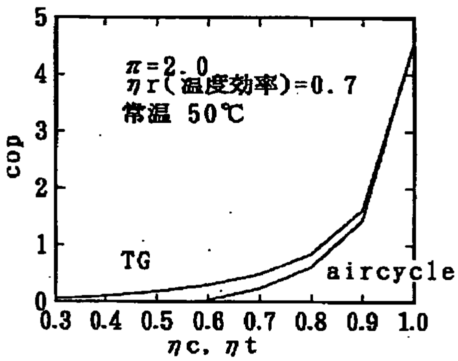


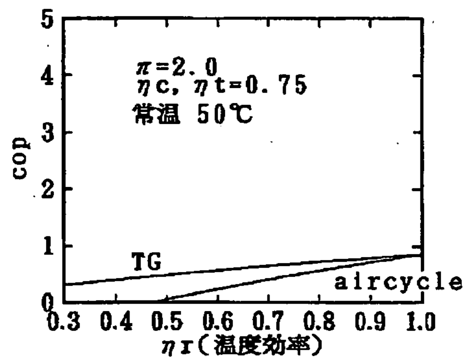
【図11】



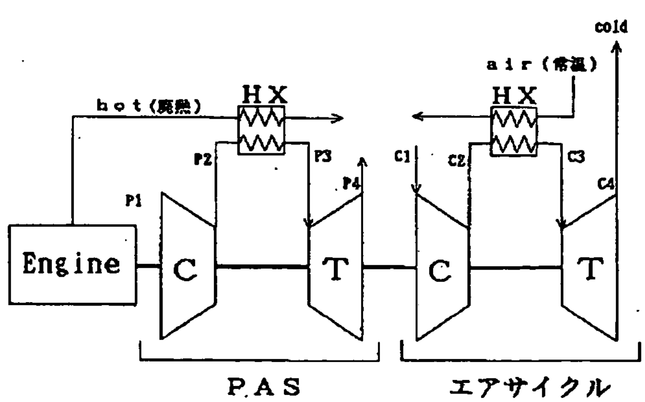
【図12】



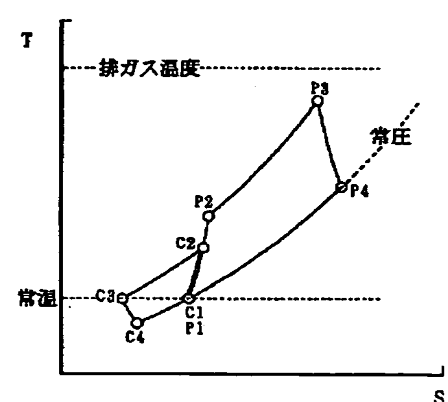
【図13】



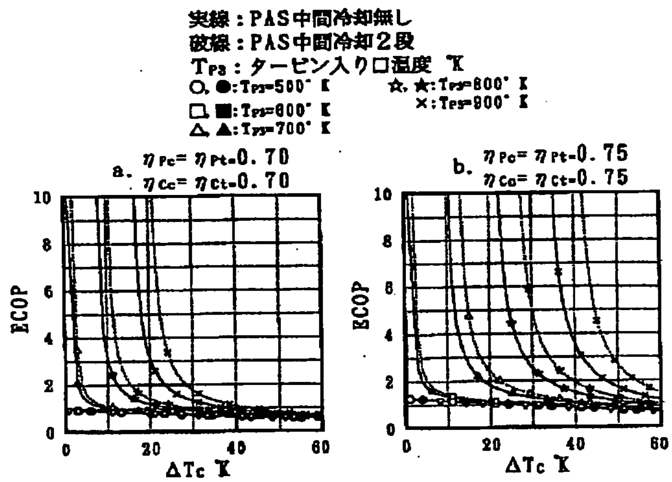
【図14】



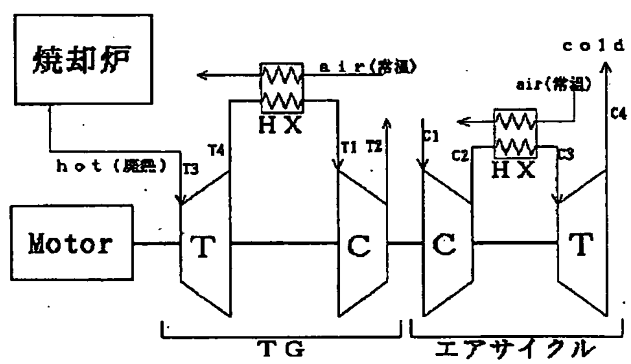
【図15】



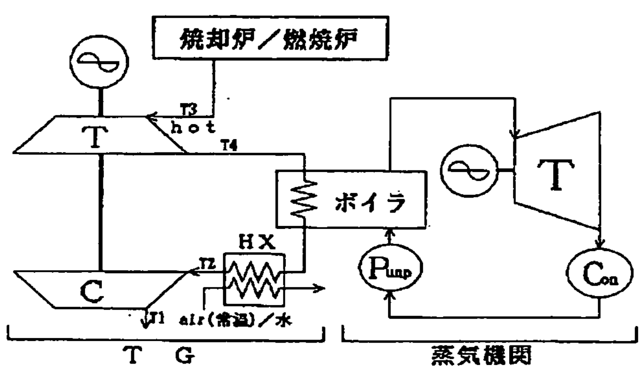
【図16】


実線：PAS中間冷却無し
破線：PAS中間冷却2段
T_{P3}：タービン入り口温度 °K
○, ●: T_{P3}=500° K
□, ■: T_{P3}=600° K
△, ▲: T_{P3}=700° K
☆, ★: T_{P3}=800° K
×: T_{P3}=900° K
a. $\eta_{Pc}=\eta_{Pt}=0.70$ $\eta_{Cc}=\eta_{Ct}=0.70$
b. $\eta_{Pc}=\eta_{Pt}=0.75$ $\eta_{Cc}=\eta_{Ct}=0.75$
ECOP
ΔTc K

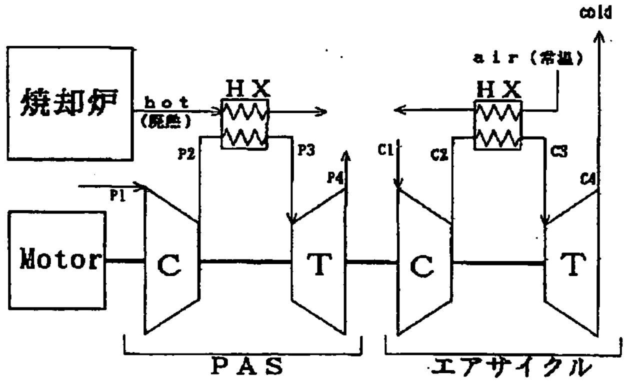
【図17】


焼却炉
Motor
hot (廃熱)
air(常温)
HX
T
C
cold
TG
エアサイクル

【図18】


焼却炉／燃焼炉
hot
T
C
HX
ボイラ
air(常温)／水
Pump
Con
TG
蒸気機関

【図19】



焼却炉
hot
(廃熱)
HX
air（常温）
HX
cold
P1
P2
P3
P4
C1
C2
C3
C4
Motor
C
T
C
T
PAS
エアサイクル

PATENT ABSTRACTS OF JAPAN

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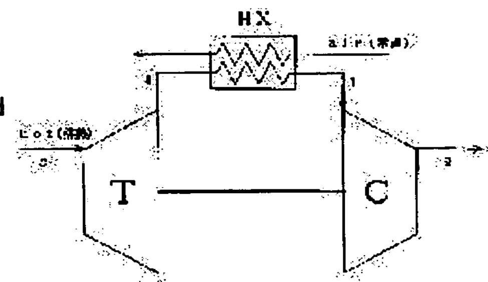
(22)Date of filing : 17.03.1997

(71)Applicant : FUJII SHOICHI
(72)Inventor : FUJII SHOICHI

(54) THERMAL ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the energy efficiency by flowing the hot gas of the normal pressure or the pressure close thereto into a turbine to achieve the work, exchanging the heat of the hot gas leaving the turbine with cooling air to drop the temperature of the gas, and flowing the gas into a compressor to generate the output.



SOLUTION: The gas 3 of high temperature and normal pressure is introduced in a turbine T to achieve the work, and the gas 4 which completes the work and is discharged flows into a heat exchanger HX, and the temperature is dropped to the normal temperature or the temperature close thereto through the heat exchange with the cooling air. After the gas 1 whose temperature is dropped is fed to a compressor C to rotate it, the gas is discharged outside. The turbine T can be driven with the gas of normal pressure by arranging the compressor C on the downstream side of the turbine T, and the difference between the output of the turbine T and the input required by the compressor C is taken out as the engine output. The gas to be used includes the exhaust gas from the engine and the hot gas generated in treatment of the refuse.

LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Equipment characterized by making ordinary pressure or the elevated-temperature gas of the pressure near it flow into a turbine, carrying out heat exchange, lowering the temperature of gas behind a turbine outlet, making it flow into a compressor, and obtaining an output.
[Claim 2] Equipment characterized by making the gas of ordinary temperature or the temperature near it flow into a turbine, carrying out heat exchange, raising the temperature of gas behind a turbine outlet, making it flow into a compressor, and making it operate as a refrigerator using the output of the equipment of claim 1, or other general power.
[Claim 3] Equipment which inhales the gas of ordinary temperature or the temperature near it from a compressor, carries out heat exchange to the elevated-temperature gas of the exterior of a low consistency which is not high as for a pressure like exhaust heat of the engine of a vehicle, and is characterized by raising the temperature of internal gas, putting into a turbine, and obtaining shaft power.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] When exhaust heat, such as a gas turbine, and a car engine, an industrial recipro engine or dust incineration, can be used, energy use effectiveness can be raised by using this invention. Moreover, this invention can be used as the refrigerator using air, i.e., an air cycle.
[0002]
[Description of the Prior Art] Although it is made to flow from a compressor, and heat exchange is carried out, temperature is lowered and it is made to flow into a turbine when it is usually carried out through the steam turbine or the calorifier for obtaining power using exhaust heat of the gas which is not high as for a pressure and is made to operate as a refrigerator, a coefficient of performance is as low as it being difficult to lower temperature to ordinary temperature at a turbine inlet port conjointly.
[0003]
[Problem(s) to be Solved by the Invention] a pressure is not high -- almost -- the heat source of the elevated-temperature gas of ordinary pressure -- using -- the time -- carrying out -- a liquid -- using -- a steam or warm water -- changing -- the former -- a technique -- a condenser -- needing -- a complicated system -- becoming . Or although exhaust heat recovery can be carried out in a turbine not using a liquid, if a direct turbine is put, for example on the exhaust port of the engine for cars, comparatively big back pressure will injure the engine performance of the engine of starting origin. This invention conquers these faults and performs efficient exhaust heat use by the easy system. On the other hand in this invention, it will use for the gas of the ordinary temperature instead of exhaust heat, and the coefficient of performance of a refrigerating cycle will be raised.
[0004]
[Means for Solving the Problem] Temperature T and the entropy S diagram showing the operating state of gas for the conceptual diagram equivalent to claim 1 of this invention in drawing 1 are shown in drawing 2 . The gas of an elevated temperature and ordinary pressure flows into Turbine T, lowers temperature to ordinary temperature or the temperature near it by the heat exchanger HX, flows to Compressor C, and is discharged by the external world. A turbine can operate by the gas of ordinary pressure, because a compressor is back, and the difference of the output of a turbine and the input which a compressor needs is taken out as engine power. What is necessary is just to use the engine of gestalten various as gas to a turbine, and the exhaust gas of a gas turbine. Or although it is the elevated temperature produced in refuse disposal, the gas which is not high as for a pressure can also be used. If the gas which has temperature T and the entropy S which is in the condition of 3 when drawing 2 explains this passes a turbine, it will be in the condition of 4. If heat is taken by the heat exchanger, it will move to the condition of 4-1, it will pressurize and heat with a compressor, will be in the condition of 2, and will be discharged by the external world. If ordinary temperature gas flows into a turbine instead of elevated-temperature gas as stated to claim 2, it can operate as a refrigerator. In this case, only the part which run short from the outside needs to apply an input in another engine.
[0005] Like the exhaust heat from the engine of a vehicle, by the usual method, when it is difficult to already carry out an energy recovery and to make it shaft power, as shown in drawing 3 , raise the temperature of the gas which passed along Compressor C by the heat exchanger HX, it is made to flow into Turbine T, and a brake horsepower is obtained using the difference of the input of a compressor, and the output of a turbine using the exhaust gas. This equipment PAS is equivalent to claim 3. Each equipment of claims 1 and 3 needs to supply a starting input from the exterior until the output of a turbine and a compressor and an input balance, i.e., it is idling, and it is the same as the operation procedure of a

general gas turbine.
[0006]
[Function] If the elevated-temperature gas of ordinary pressure was not conventionally changed into a steam or warm water, although it was not able to be used, it can carry out direct use as power only in heat exchange by this invention, without changing into a steam etc. When making it operate as a refrigerator, a turbine inlet port is ordinary temperature or the temperature near it, i.e., an OAT, and is not surely influenced by the engine performance of a heat exchanger at the time of an inflow.
[0007]
[Example] The case where the equipment TG of claim 1 by this invention is used combining a gas turbine is shown in drawing 4 . In this drawing, a heat exchanger and C use as a compressor and T uses a combustor and HX as a turbine for B. The operating state of gas is shown in drawing 5 . Temperature is raised by the playback for which the air in the condition of G1 is inhaled, it is compressed into G2, and G2 to G5' uses the heat of exhaust gas, and even G3 becomes an elevated temperature from G5' further by combustion. This gas becomes the air G4 of an ordinary pressure elevated temperature by passing a turbine. This is anew named the condition of T3. Temperature falls in the condition of T four in the turbine attached to the equipment TG of claim 1 of this invention. this elevated-temperature gas -- further -- heat exchange -- G6' -- it is further lowered to T1. It is used for the heat produced from T four in the process which goes to T6' raising the gas in a gas turbine from G2 to G5'. To T1, it cools compulsorily from the outside from G6'. It is pressurized by T1 to T2 with a compressor, and is emitted to the external world. This cycle diagram has become, when it is in ordinary temperature in ** and a part intrercools a compressor with a gas turbine simple substance so that it may see by drawing 5 . Such a gestalt is calculated thermodynamically and a result is shown in drawing 6 . An axis of ordinate expresses output deltaTWTG by the equipment TG of this invention with the unit of temperature in this drawing, and an axis of abscissa shows expansion ratio pir accompanying turbine passage of TG. the effectiveness of the heat exchange of TG -- 1.0 -- carrying out -- the effectiveness of the heat exchange in the case of the playback to a gas turbine -- 0.8 and 0. -- when not considering as the case where 4 and 0 changed three kinds and it intrercools to the compressor of TG, it divided and calculated. Effectiveness of heat exchange was made into the ratio of the actual amount of heat transfer and the actual amount of heat transfer in which max is possible here as generally known. etain drawing e is the adiabatic efficiency of a gas turbine and the element of TG, and that it is with 0.70 shows that all of a gas turbine, and the compressor and turbine of TG are operating with 70% of adiabatic efficiency. here -- the adiabatic efficiency of an element -- two kinds -- changing -- 0. -- 70 and 0.75 were calculated. It became clear that an output was obtained from the equipment TG of this invention in any case.
[0008] In order to use for drawing 7 the output of the equipment TG of this invention stated to claim 1, the case where the usual air cycle refrigerator is linked directly is shown. Temperature T and the entropy S diagram corresponding to this are shown in drawing 8 . It is important, Ratio COP, i.e., the coefficient of performance, of the need [of receiving refrigerating capacity in a refrigerator] input. Two kinds (0. 70 0.75) of adiabatic-efficiency etae of an element was changed, three kinds (0. with 8, 0.4, and no playback) of energy effectiveness epsilonGR(s) for the playback to a gas turbine were changed further, and drawing 9 calculated the relation of temperature-gradient **Tc of COP, an air cycle inlet port, and an outlet based on the equation of thermodynamics. It receives, although an alternate long and short dash line is only an air cycle, and the coefficient of performance COP is improved by leaps and bounds under the condition of a gap.
[0009] Temperature T and the entropy S diagram which is equivalent to drawing 10 in the conceptual diagram when using as a refrigerator the equipment GT of this invention stated to claim 2 are shown in drawing 11 . The air of the condition of 3 is expanded in a turbine, heat exchange of the temperature is carried out to the lowering exterior, and temperature is again raised from 4 to the condition of 1. The cold exterior air obtained by heat exchange is applicable to air conditioning or refrigeration. Thermodynamics count was performed and drawing 12 and 13 compared a usual air cycle (AIRCYCLE) and usual TG about the coefficient of performance COP. Drawing 12 compares the coefficient of performance COP to change of each adiabatic-efficiency etac of a compressor and a turbine, and etat (referred to as etac=etat). Temperature efficiency of heat exchange is set to etar=0.7. Even if the adiabatic efficiency of an element is bad, TG by this invention has COP larger than the conventional air cycle. from current aerodynamic engineering, 0.8 or more adiabatic efficiency of an element is desired neither in a small compressor nor a turbine -- in view of things, TG is advantageous compared with an air cycle. Drawing 13 shows the predominance of TG to temperature efficiency etar of a heat exchanger. In count, it considered as eta c=eta t= 0.75 and a pressure ratio pi= 2.0. Actually, if it takes that it is hard to think into consideration, 0.8

or more temperature efficiency will not change the predominance of TG, even when temperature efficiency is bad.
[0010] The conceptual diagram at the time of making it operate as auxiliary power which applies the equipment PAS by this invention stated to claim 3 to the engine of a vehicle, and uses exhaust heat, and raising the economical efficiency of a car cooler is shown in drawing 14 . Although above-mentioned TG may be used as a refrigerator, in order to give explanation brief here, the case where the usual air cycle is connected is described. Although they is corresponding temperature T and entropy S diagram, drawing 15 carries out heat exchange to hot exhaust gas, raises the temperature of the gas in PAS to P3 from P2, becomes after [P4] turbine passage, and is discharged. The output obtained by this and an engine output are applied, and an air cycle is operated. It is drawing 16 which was displayed by performing thermodynamics count to such a system. In this drawing, ECOP is a newly defined economical coefficient of performance. Although the coefficient of performance COP is generally defined by the ratio of refrigerating capacity and an input required for it, since in now energy which is called exhaust gas and which becomes useless is used if it remains as it is, let what deducted the output produced by PAS from the input required for refrigeration, and asked for the coefficient of performance be the economical coefficient of performance ECOP. That is, it means investigating a coefficient of performance from an economical standpoint physically unlike strict COP. By a diagram, etaPc and etaTc are the compressor of PAS, and the adiabatic efficiency of a turbine. etaCc and etaCt are similarly taken as the compressor of an air cycle, and the adiabatic efficiency of a turbine. deltaTc is taken as the temperature reduction by the air cycle. When PAS is used seen from this drawing, it turns out that the economical coefficient of performance of an air cycle is raised.
[0011] The example which applied the equipment TG of this invention to the waste disposal plant is shown in drawing 17 . In this case, auxiliary power Motor is needed instead of a gas turbine or an engine.
[0012] The example which applied the equipment TG of this invention to the incinerator, and was interlocked with the steam turbine is shown in drawing 18 . Pump shows a pump and Con shows a condenser in this drawing. Exhaust heat use is made into a three-stage from two conventional steps, and the bottom puts [temperature] into a boiler in the state of **** to some extent with the equipment TG of this invention, using the part of the maximum temperature of a system first. Since corrosion took place influenced by the ingredient when it put into the boiler at the elevated temperature conventionally, it cooled with water etc. and temperature had been lowered specially.
[0013] When the equipment PAS of claim 3 is used for an incinerator instead of the equipment TG of this invention of claim 1, ** is shown in drawing 19 R> 9.
[0014]
[Effect of the Invention] With the equipment TG of claim 2 of this invention, since gas is made to flow into a turbine previously, generally 100% of effectiveness of the difficult heat exchange of implementation is always guaranteed at the time of an inflow. Moreover, since there is a temperature reduction of about 100 to 150 degrees in a turbine at the time of elevated-temperature gas, the material selection of the heat exchanger which continues after that becomes advantageous. With the equation of thermodynamics, since it is calculated in the form of a pressure ratio, when a ratio is the same, since there are few absolute values of differential pressure, the direction of negative pressure becomes advantageous structurally.
[0015] Drawing 7 and the effectiveness which the coefficient of performance COP of an air cycle increased with the equipment TG of this invention by 8 and 9 are described below. When work of W is required, generally COP=Q/W is defined as acquiring the refrigerating capacity of Q. If the equipment of this invention is attached, as shown in drawing 8 , with a cycle diagram, it would come to have intrercooled and the effectiveness E of a gas turbine simple substance will rise to Et. Therefore, COP=Q/(W-G (Et-E))
COP improves from ******. G is taken as the heating value which input gas has by the upper formula. supposing it uses it for driving only a refrigerator without a gas turbine's generating electricity -- the ratio of refrigerating capacity and an input -- QE/W is improved by QEt/W and only G (Et-E) can save the heating value of gas.

[Translation done.]

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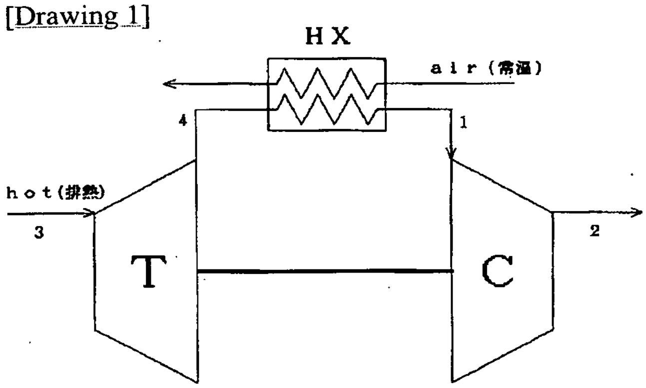
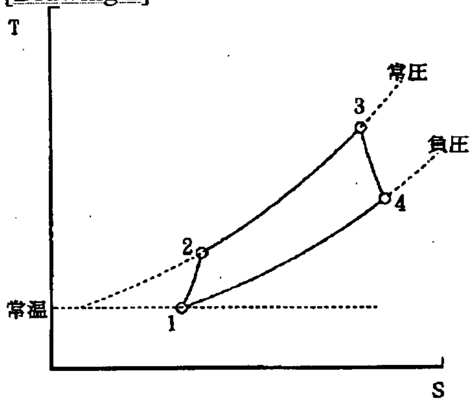
3.In the drawings, any words are not translated.

DRAWINGS

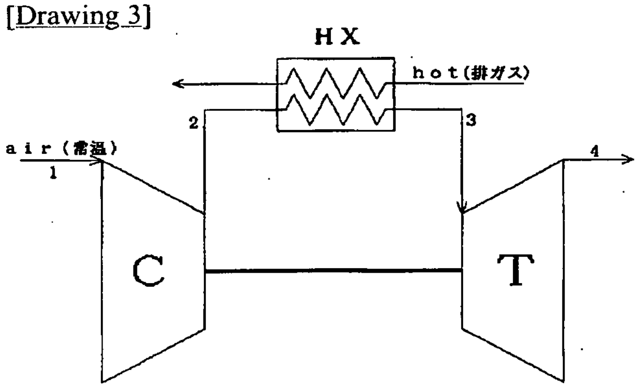
[Drawing 1]



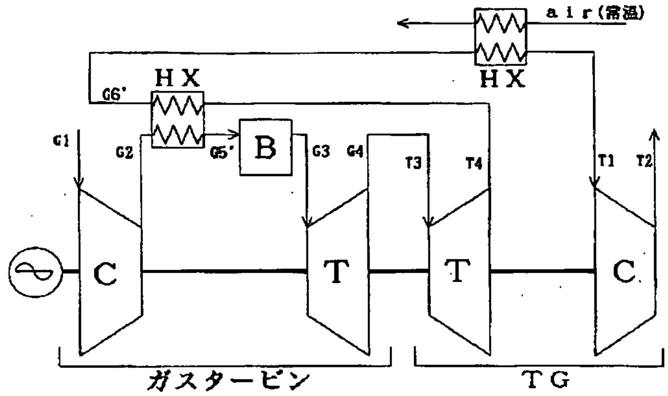
[Drawing 2]



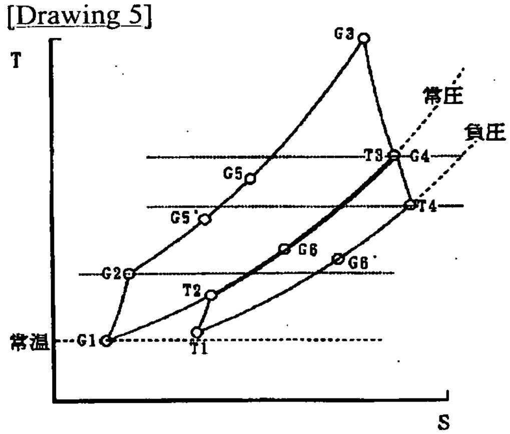
[Drawing 3]



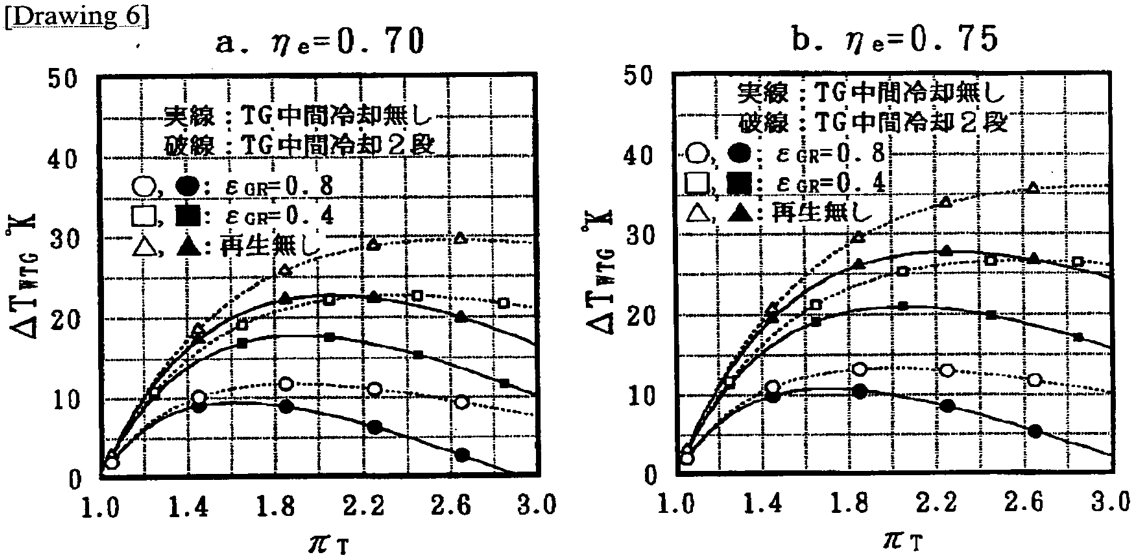
[Drawing 4]



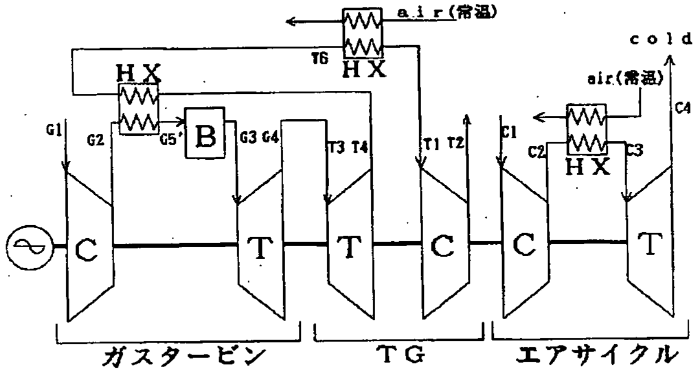
[Drawing 5]



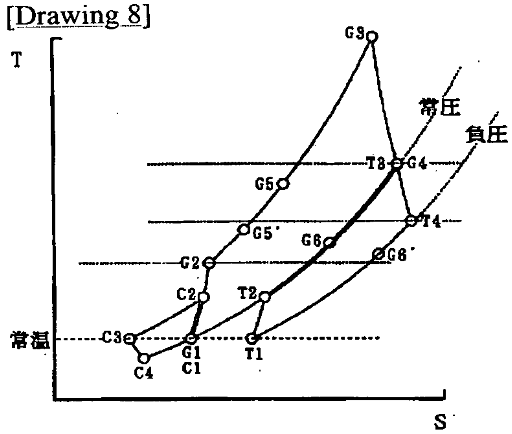
[Drawing 6]



[Drawing 7]

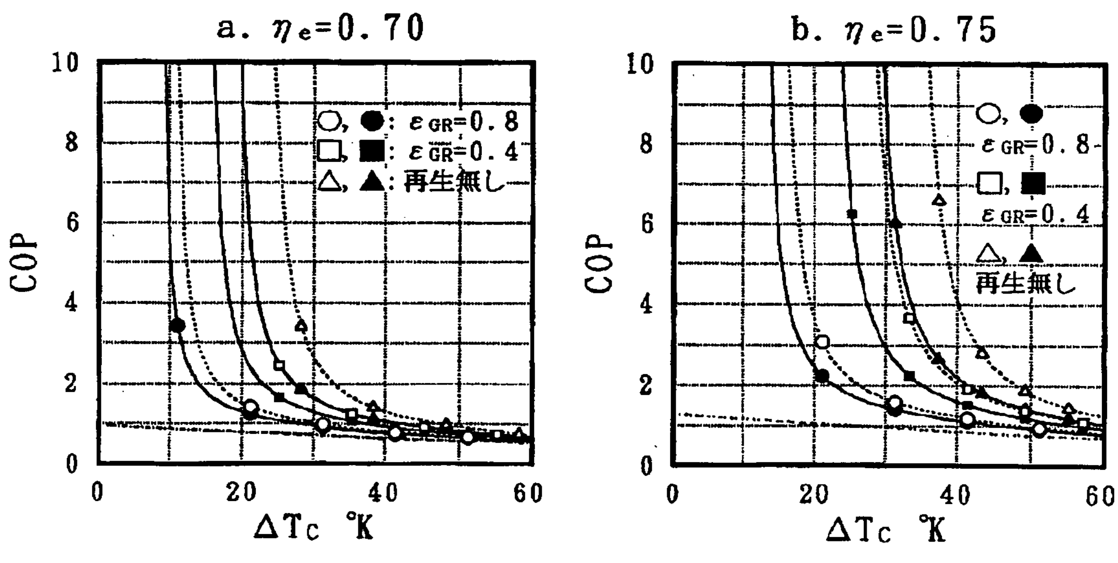


[Drawing 8]

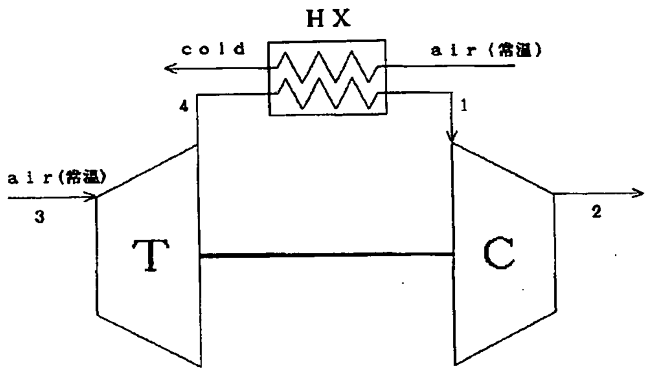


[Drawing 9]

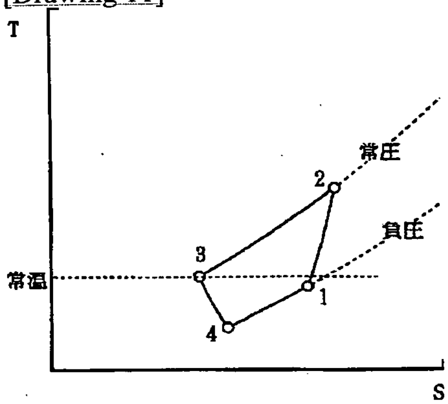
実線：ＴＧ中間冷却無し
破線：ＴＧ中間冷却２段
一点鎖線：エアサイクルのみ



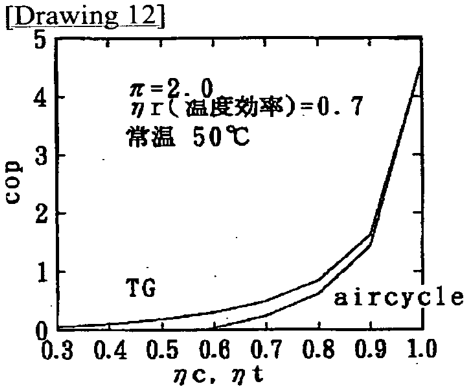
[Drawing 10]



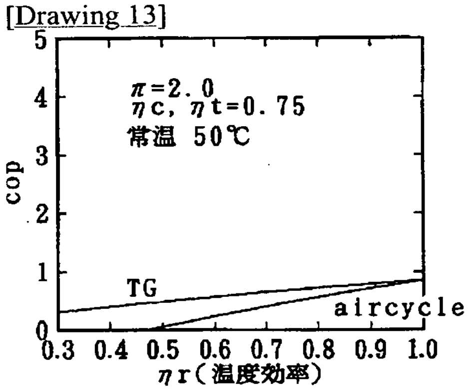
[Drawing 11]



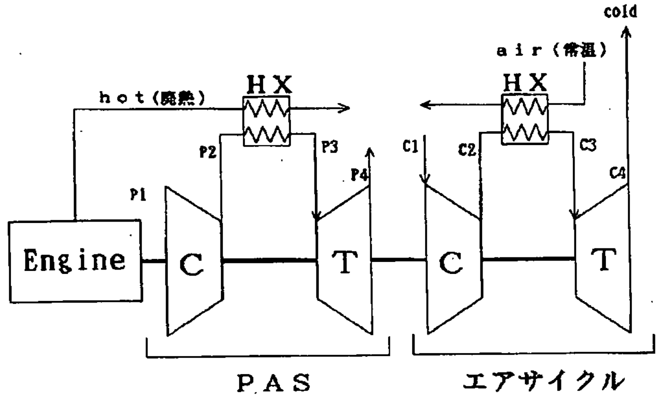
[Drawing 12]



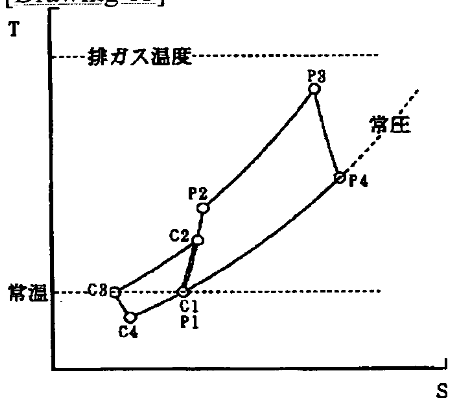
[Drawing 13]



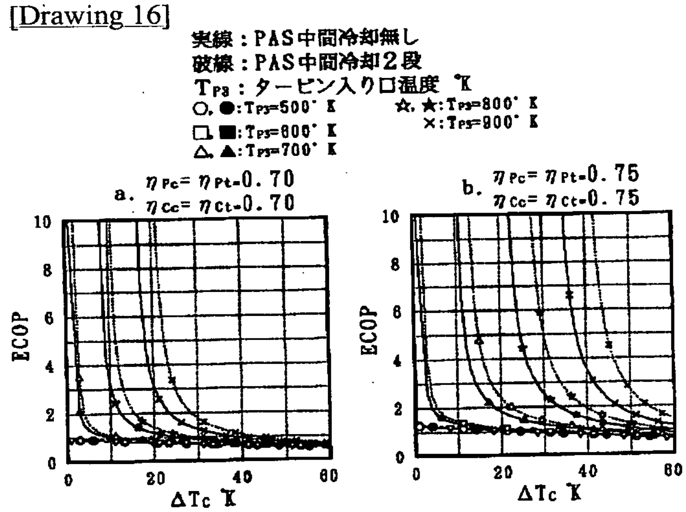
[Drawing 14]



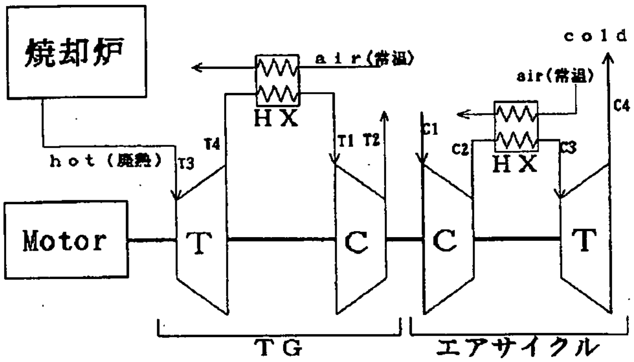
[Drawing 15]



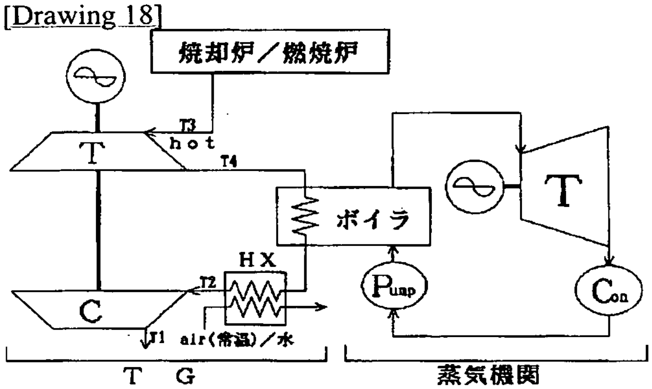
[Drawing 16]



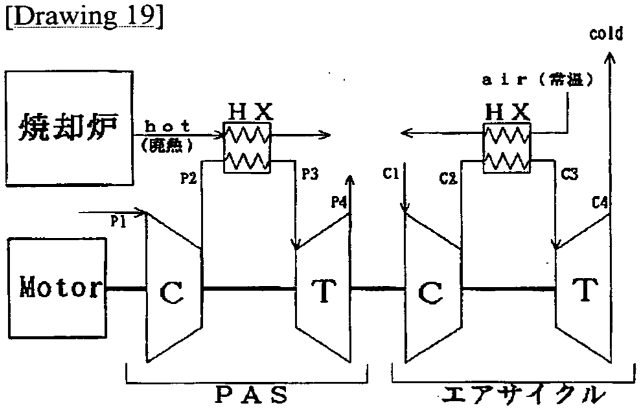
[Drawing 17]



[Drawing 18]



[Drawing 19]



[Translation done.]